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FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS

IN THIS ISSUE

THE SEVENTH YEAR

In this, the first issue of EMI's seventh year, we have a couple of good follow-up articles. Continuing last issue's investigation into the extraordinary acoustic properties of conjoined string systems, there are reports from several builders who have made instruments using sets of interconnected strings. And following our earlier discussion of patenting for musical instruments, we have "a day in the patent library," describing a foray into that great repository of ideas and dreams, with data on several noteworthy musical instrument designs that were happened upon there. We also have a major article on computer-activated acoustic instruments, with an emphasis on computer-controlled, electromechanically-played pianos. And herein you will find a description of John Starrett's Starrboard, a fretted electric zither whose eminently logical design nicely demonstrates the implicit potential of finger-tapped strings. EMI then invites you down to the beach to make the simplest instrument of all, a driftwood marimba. Please join us now in our summer's new year.

COMPUTER CONTROL FOR ACOUSTIC INSTRUMENTS

By Bart Hopkin, with Alec Bernstein and Alistair Riddell

Computer technology has brought with it a revolution in electronic music. This is not news. Less familiar, however, is the idea that computer technology has a role to play in acoustic music performance. In the article that follows, we look at computer control systems designed to play acoustic musical instruments, by means of electro-mechanical devices that take the place of human hands. After an overview of some of the possibilities, we will focus on the work of three composer/builders in the field: Alec Bernstein working with Daniel Carney, and Alistair Riddell.

In August, 1990, EMI ran an article on the player pianos and other mechanical instruments that enjoyed a tremendous popularity in the decades surrounding the turn of this century. These were machines designed to play automatically the popular tunes of the day, usually on familiar instruments such as banjos, violins and pianos, minimally altered for the purpose. In many respects, such instruments were the precursers of the computer-controlled instruments we'll be discussing here. But their creative use was limited in this respect: they were rarely used to explore new com-

(Continued on page 8)

DRIFTWOOD MARIMBA. See the article on page 7.

NOTES FROM RECENT CORRESPONDENCE

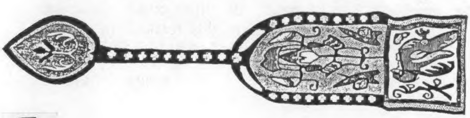
EMI's FEBRUARY ISSUE featured an article by David Myers on compound feedback systems using multiple interconnected digital delay units. With that in mind, Henry Lowengard notes, "Folks who like Arcane Device and similar feedback music should get their paws on a harmonizer or two and listen to the feedback there!" For more on the interactive possibilities of pitch shifting devices such as the Harmonizers manufactured by Eventide, see Henry's article "Methods for Multiples" in **Ear** Vol. 14 #6, Sept. 89 (131 Varrick St., Rm 905, New York NY 10013).

FRANCISCO LOPEZ sends this information about his current projects in cityscape soundwork:

> I'm now making two works about two Spanish cities (Vigo and Alcalá). We will make both concerts soon, and they will include video works in addition to the sound.
>
> The basic idea of the project is to use the city soundscapes as instruments. I usually do about 4 to 8 hours of recordings and then select for the live mix, using the sounds in concert as a painter uses colors to make a painting. I intend to do this kind of soundscape portrait in different places throughout the world.
>
> As a parallel activity very close to this, since 1985 I've recorded many sound environments in different countries and I'm now working with these sounds in two different works: one about Brazil (titled "Ele é um Espião" (= "He is a spy")) and one about the Ottoman Empire, with recordings from Turkey, Bulgaria and Rumania.
>
> I would be very interested in contact with other people from all over the world working/interested in this kind of sound work.

Contact Francisco Lopez at Apartado 2542, 28080 Madrid, Spain.

FOLLOWING BILL SETHARES' ARTICLE on 19-Tone equal temperament for guitar in EMI's last issue, Ivor Darreg sent along a copy of his **Xenharmonic Bulletin #7** (1976), plus a reprint of his article "Re-Fretting and Fret-Lining", which first appeared in **Interval** Magazine in the early 1980s. The two are devoted to the idea of refretting – that is, relocating the frets on a guitar to allow for playing in tunings other than the standard twelve tone equal temperament. The Bulletin piece includes fret spacing charts for 17, 19, 22, 24, 31 and 34 tone equal temperaments, along with practical information on putting them to use. The **Interval** article generally discusses and promotes the idea of re-fretting, as well as the use of visual fret lines (painted on; not raised) for sliding steel style playing. Both are available from Ivor Darreg at 3612 Polk Ave., San Diego, CA 92104.



EMI'S NEWEST CASSETTE TAPE AVAILABLE THIS MONTH

OK! **From the Pages of Experimental Musical Instruments Volume VI** will be available within the month, and we are taking orders now. The cassette tape contains music from instruments featured in the six issues of EMI volume VI, from June 1990 through April 1991. A dozen different instrument types appear, including:

Bob Fenger's **Acousticizer,** an electroacoustic prepared piano;

Ed Stander's **Musical Glasses;**

Tom Guralnick's **(Not So) Mobile Mute Unit**, a battery of saxophone-based instruments;

tENTATIVELY, a cONVENIENCE's **Booed Usic Busking Unit**, a street music/noise performance set up using cheap electronics;

Phil Dadson's **From Scratch** ensemble, using an array of large scale percussion aerophones and idiophones;

Jim Nollman's duets with sea mammals and underwater electric guitar;

Tobias Kaye's **Musical Bowls**, turned wooden bowls withstrings;

Old time automatic musical instruments from the collection of The Musical Museum in Deansboro, New York;

H. Barnard's **Matzaar**, a guitar refretted to a peculiar scale of the type known as "Aliquot";

John Jordan's **9-string guitar**;

Tom Nunn's **T-Rodimba**, an electroacoustic percussion board with a variety attached sound sources;

Richard Graham's **Diddley Bows**, glissed monochord zithers based in African-American tradition;

David Myer's **Feedback Machine**, an interlocking network of delay units;

And **Multiple Corrugahorns**, corrugated tube aerophones arranged in tuned sets on a single mouthpiece and air reservoir.

– All good stuff!

The Volume VI tape, along with its predecessors Volumes I through V, are available to EMI subscribers for $6 apiece, and to non-subscribers for $8.50. Checks should be made out to Experimental Musical Instruments, PO Box 784, Nicasio, CA 94946, USA.

NEW INSTRUMENTS IN *MUSICWORKS:* The Canadian music journal **Musicworks**' issue #49 (winter 1991) features several articles on new instruments. The articles stem from the **Sounds of Invention** exhibit that took place at Memorial University Art Gallery in the summer of 1990 as part of the Newfoundland Sound Symposium. The exhibit was organized by **Musicworks** editor Gayle Young. She authored the first of the articles in this issue, "Playing the Aural with the Visual", as an overview of the exhibit. Especially valuable are her observations on just which aspects of the exhibit were most successful for which exhibit-goers and why – questions which can be especially vexing in connection with the planning of sound sculpture exhibits. She also describes, with the aid of a number of photographs, several of the pieces. Among them: *Sprong*, made by Sylvia Bendza, incorporated dustpans and tennis balls on a brightly painted bed frame, with a pail of wooden spoons and nails beneath. "Children about one year old were fascinated by the wooden spoons, and stirred the nails eagerly ... some adults of musical persuasion were seen to remove the dustpans and engage in a limited game of

dustpan tennis ... Most contented themselves with an exploration of the various parts using the percussion mallets." Bill Napier Hemy's *Strumming Instrument* is a keyboard-controlled chordophone. Eight strings for each note are mounted on rotating carriers. When a key is depressed, the strings of the associated note are plucked in rapid succession. Gordan Monihan's *Music From Nowhere* involved loudspeaker cabinets with their innards removed and replaced with quiet acoustic sound making mechanisms. These were not conceived as sound machines, but rather conceptually evocative scenes which happened to make sounds, such as a urinating mannequin and a rotating turntable with two clinking Chinese exercise balls. An observer in front of the speaker would only hear the sounds emerging, as if from a recorded source, but from the rear the sound scenes were visible.

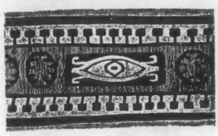
Another of the articles in **Musicworks** 49, Gianfranco Salvatore's "Can Archetypes Be Heard?", discusses musical archetypes, with a particular emphasis on the ritual effect of sound-producing objects. Bullroarers and shell trumpets figure prominently.

Musicworks 49 also features an interview with Ushio Torikai, conducted by Sarah Peebles. Torikai plays shamisen, and has recently integrated it into non-traditional settings. She has also worked with some extraordinary performance art sound sources: "Turning dials and pressing buttons on a variety of electronic devices, she casually and sometimes nonchalantly tossed porcelain plates onto a sound-producing metal platform. As the plates spilled on top of one another, the composer diligently altered and shaded the sounds of the shattering plates as they intermingled and collided with the electronic sounds and reverberated throughout the gallery."

"The Improvisation Moderator" is an interview with Nicolas Collins, conducted by Guy De Bièvre. Much of the discussion focuses on Collins' *trombone propellor*, a trombone body wired to serve as a controller for synthesizers, samplers or sequencers. Printed alongside the interview are proposals for sound installations. *Table de Séance* is one; it suggests using sensors recording the location of a wineglass on a séance table to input information into a computer. The computer in turn calls up pre-recorded sounds "from the other side", and sends them to loudspeakers concealed in props (period furniture, gramophone, French horn, framed mirror, etc.) around the room.

Musicworks provides a caassette tape along with each printed issue. Several of the instruments covered here are included in this issues's cassette, including a 10-minute improvisation by Reinhard Reitzenstein, Don Wherry and Gayle Young on instruments from the **Sounds of Invention** exhibition.

Musicworks 49 and other s issues are available from the Music Gallery, 1087 Queen St. West, Toronto, Ontario, Canada, M6J 1H3.



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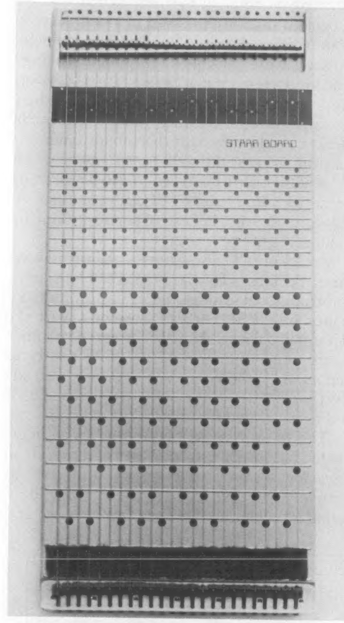
Subscribers can place relevant "classified" ads of up to 40 words without charge, and they will receive a 15% discount on display ads.

SUBMISSIONS: Experimental Musical Instruments welcomes submissions of articles relating to new or unusual musical instruments. A query letter or phone call is suggested before sending articles. Include a return envelope with submissions.

THE STARRBOARD

by John Starrett

Guitarists and players of other fretted instruments use a technique commonly called "hammering on," in which a finger of the fretting hand comes down upon the string forcefully enough to slam the string against the fretboard, and in so doing excite an audible vibration. The technique is normally used in conjunction with plucking (following a plucked note with a hammered one, so that the vibration is perpetuated at a new pitch without need of another pluck); but it is possible to play using hammering alone, with no plucking at all. This technique works best with electric guitars, where the weaker volume of the hammered notes can be compensated for. Jimi Hendrix was famous for his one-handed virtuosic displays in this realm. More recently, Stanley Jordan has developed an impressive technique built entirely around hammering on with the fingers of both hands, dispensing with plucking entirely. Other rock and jazz guitarists have followed. In the early 1970s, Southern California inventor Emmet Chapman created the stick, *a guitar-like 10-string instrument designed specifically for two-handed tapping technique [see review in EMI Volume II #4]. The stick has proven a viable, versatile and valuable instrument in a variety of musical styles, and has achieved a healthy measure of success and recognition.*



Right: 24-String electric StarrBoard.

Below left: Playing the 32-string electric StarrBoard.

Observers have often commented on the stick's keyboard-like qualities, but its kinship to electric guitar remains foremost. Yet the possibilities for a truly keyboard-like hammer-on instrument are enticing. That brings us to the topic of the article that follows. John Starrett's StarrBoard *derives in concept not solely from the guitar, with its few strings and many frets, but as well from the unfretted, many-stringed instruments, the harps and zithers that gave rise to clavichord, harpsichord and piano. The resulting instrument, and approach to playing, are quite different. Here is inventor John Starrett's report.*

A STARRBOARD IS BORN

The StarrBoard is a new fretted string musical instrument I patented in 1985 after about 2 years of development.

I didn't set out to create a new family of stringed instruments, I just wanted to improve an old one – the harp. I was working on a modulation scheme for the harp whereby a series of movable fret rods would be pressed against the strings to bring the pitch of the entire instrument up a half step for each successive rod. The fret rods would be engaged by the standard harp pedals, allowing the harp to modulate chromatically, thereby giving it a greater potential role in the orchestra. This scheme for harp modulation has advantages in the areas of of universal fingerings for different keys, and flexibility of modulation in just and other unequally-spaced scale systems.

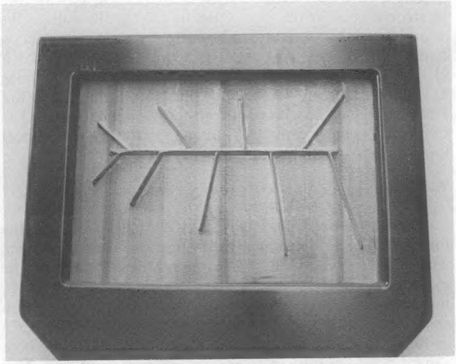
But this instrument was not to be. As I sat on the jetty at

Venice Beach, it became apparent to me that a much simpler instrument could do all these things. Instead of pressing a fret against a group of strings, I could strike the strings against the frets with my fingers, eliminating the mechanical linkage of the fret rods and pedals.

A STARRBOARD IN YOUR FUTURE?

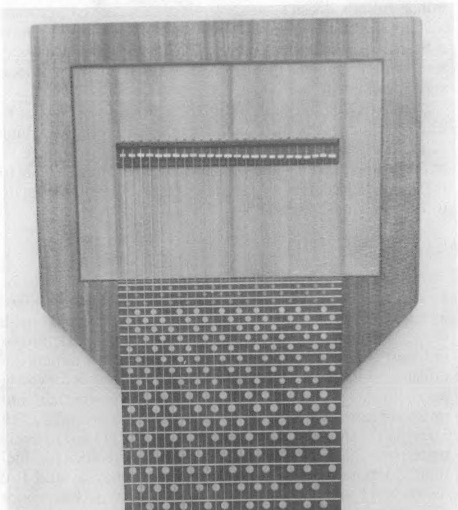
Imagine you are sitting at your desk late one afternoon, absentmindedly drumming your fingers. To your surprise, your finger drumming produces a descending scalar passage, almost as if you were drumming your fingers on a piano keyboard. You look down to see that your desk looks like a piece of graph paper, but with frets for the horizontal lines and strings for the vertical. Your boss has replaced your desk with a StarrBoard.

The StarrBoard is essentially a giant guitar neck with 32 strings, 24 frets, a pickup, tuners, and not much else. It is approximately 19 inches wide, 36 inches long and 1 1/2 inches thick. On the face of the instrument there is a pattern of dots in groups of twos and threes that glides up and to the left in a graceful logarithmic spiral. These dots indicate the location of notes that are the same as those played on the black keys of the piano. In fact, they have the same spacing as black keys on the keyboard, and the distance of an octave on the Starr-Board is identical to that of a keyboard.



Above Right: Soundboard for the acoustic, seen from behind with the bracing pattern visible

.Below: 25-string acoustic StarrBoard



LET'S GET PHYSICAL

For the first three StarrBoards, I used double wide laminated maple piano pin planks for the body. When my supplier switched from first class, flat birdseye planks to warped and checked wood with no figure, I began laminating my own from Baltic birch, which I still use. The frets are made from jumbo fret stock, which I buy from GHS Strings. The strings are standard guitar and bass strings. The tuners are made of brass, aluminum and steel, as are the string retainers and the bridge. The pickup cover and control cavity cover are made from ABS plastic, and the pickups are wound on bob-bins of Nylatron.

I have built 11 different StarrBoards to date. The first three had 35 strings and were tuned using piano tuning pins. The piano pins turned out to be more trouble than they were worth. So I retrofitted the instruments with micrometer style tuners, which I use to this day with only slight modifications. I built one StarrBoard with a slanted fret scale, going from a 34 inch scale on the bass side to a 25 inch scale on the treble side. This gave a slightly more even tension between the bass and treble strings, but the highest notes on the treble strings didn't have as much volume as they did on the longer scale. I now use a 30 inch scale for the standard StarrBoard. I find that this length is a good compromise. Any floppiness in the bass strings can be eliminated by using a thick enough string. The StarrBoard is strung from high to low beginning with .010 plain and ending with .068 wound. The difference in the string size from string to string is generally one thousandth for the plain strings and two thousandths for the wound strings.

I have built one acoustic StarrBoard and am constructing another. The first had 25 strings and a spruce soundboard about 24 inches wide and 16 inches deep. The fingerboard was Bolivian rosewood with inlaid maple position markers. The sound board, however, turned out to be too small to give an adequate volume, so for my 32 string acoustic, now under construction, I have built a sound board measuring 38 inches by 30 inches. The bracing pattern on the first acoustic was a modified Kasha pattern that looks like a fish skeleton. This seems to work well, but I am not certain of how I will brace acoustic #2.

I have built two MIDI StarrBoards. Excluding the electronics, these differ from the standard StarrBoard in only

a couple of ways. Each fret and each string has its own electronic connection. In order to electrically isolate the strings, I use Delrin plastic or Nylatron for the bridge pieces, tuning blocks and string retainer. The string-fret matrix is electronically scanned to determine which strings are being held down, and the appropriate MIDI code is output. So far, I have implemented a monophonic output, but I have hired an electrical engineer who is assisting me in the construction of the polyphonic MIDI.

THE SOUND OF TWO HANDS TAPPING

The StarrBoard sounds a lot like a clavichord, because the tone is produced in essentially the same way – a metal string and a metal bar collide, setting the string vibrating. The electric StarrBoard sounds a little more like an electric guitar, however, and the acoustic is not yet quite as loud as a clavichord. StarrBoard notes can be bent and slurred as on a guitar. Also, because of the way it is laid out, the same note can be played in several diagonally adjacent positions. This allows you to play rapid repeated notes (similar in sound to a classical guitar tremolo), rapid repeated chords, and effects using the same notes played together. This last effect can be used to make a phasing sound when the same chord is played in two positions simultaneously and a vibrato is used on one or both chords. This makes the pitches go in and out of phase with each other, which is similar in sound to two different instruments playing the same thing in unison. Also, a melody can contain a note identical to one already sounding in a chordal accompaniment. Few other instruments can do this.

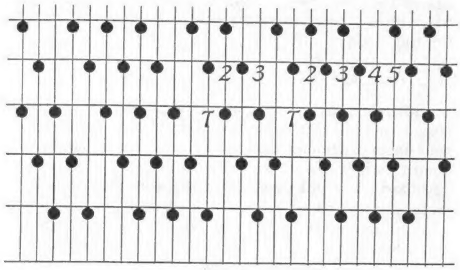
The actual physical technique of playing the StarrBoard is similar to that of a keyboard. The fingers hover over the playing area and drop onto the appropriate note, holding it down as long as the note is to sound. On the StarrBoard, instead of dropping onto keys, the finger is dropping into strings. The impact of the string hitting the fret gives the string enough energy to set it vibrating. The harder the string is struck to the fret, the louder the note will be.

In addition to choosing a string of the proper pitch, the StarrBoard player must also choose the proper fret. Playing up one fret (away from the body, towards the top of the instrument) has the same effect as playing up one string – the note sounds one half step higher. Having to choose both a fret and a string is not as confusing as it sounds. It's the same choice one makes when playing a guitar; which position will make this passage easier? However, unlike the guitar, the StarrBoard's position markers indicate the note for every string-fret combination, not just the frets.

Since the Starrboard is tuned in half steps string to string, and the frets change the pitch by half steps fret to fret, playing the StarrBoard is like tapping on a two-dimensional grid, where playing up or down a fret has the same effect on the pitch as playing up or down one string. Because of the symmetrical layout of the Starr Board, fingerings for chords, scales and melodic patterns are the same, no matter what key they are played in. For instance, a C major scale has the same fingering as an E flat major scale; it is just played up three frets or three strings. Of course, this greatly simplifies learning the basics. From a physical standpoint, the StarrBoard is remarkably easy to play. Pushing the string down against the fret takes less force than depressing a piano key. It is not necessary to pluck the instrument, so the coordination of two hands to sound one note is unnecessary.

One of the most unusual things the StarrBoard can do is

Fingering chart for a C Major scale. Scale patterns can be moved up or down to other frets, or side to side to other strings, to produce the same scale in other keys.



play in just, meantone, or other unequally-spaced tunings in 12 different keys. Because modulation may be accomplished by playing on a higher fret, the strings may be tuned to whatever tuning is desired, and the relationship will stay the same, as long as any modulation is done fretwise. Of course, the modulation will be to a key a 12-tone-equal-tempered distance away. I have found that this is not disturbing to the mood of the tuning. Most modulations are to a key center a perfect fourth or a perfect fifth away, and these relationships are so close between 12 tone equal temperament and just tuning that it is difficult to tell the difference. Even modulation to one of the out of tune keys, such as the major third or minor seventh, doesn't sound off, since these are consecutive, and not simultaneous tones. It would not be difficult to build a StarrBoard with custom fret spacing to make it a justly tempered instrument through and through, or to build one with adjustable fret spacing.

The MIDI StarrBoard offers even more power, as far as different tunings go. It could be set up to play in any tuning at all, stringwise, and the frets could be set to the same or another tuning. You could play in meantone and modulate to meantone key centers, or play in Pythagorean and modulate to 19 tone equal tempered key centers.

COME OUT AND PLAY

There are many techniques and approaches yet to be worked out for this instrument. I have played the StarrBoard in many jazz settings and a few composers concerts. Though the response has been universally positive, I find what I need the most (besides Yamaha buying the patent for millions of dollars and making StarrBoard a household word) is for young people with open minds to start playing the instrument and inventing new techniques. I currently custom make each StarrBoard, and even with a price of $3,100.00 I am severely underpaying myself for the work involved. With mass production and mass marketing come mass acceptance, and I've discovered I am not a marketeer. I will be approaching major manufacturers at the 1991 NAMM show to try to work out a deal to get the StarrBoard out to the public at a reasonable price.

Designing and playing new musical instruments is gratifying work, but life is too short to spend it all on one project. Let's see, how about a MIDI Jew's harp?

DRIFTWOOD MARIMBAS

by Bart Hopkin

Above: Driftwood marimba made by the author and son, California north coast, 1989.
Below : Driftwood marimba made by Alec Bernstein, Clark Island, 1976.
Photo below by Julian Shapiro

Sometime when you find yourself at an ocean beach, or at some stream or river which has had its way with a lot of downed wood, try making a driftwood marimba. Nothing could be simpler.

To begin, find a place where there is an abundance of beached wood scattered about. Find two relatively long, straight-ish pieces to serve as the supports for the sounding bars. They will be laid down alongside one another, a little out of parallel, and the bars laid across them. Find a couple of sticks to use as beaters. Use anything reasonably solid that seems comfortable in size and weight and balance (later you can look for other beaters more carefully chosen to bring out the best in the completed marimba).

Then begin auditioning driftwood pieces to serve as sounding bars. An easy way to test a piece of wood for its musical properties is to toss it in the air and strike it near the center in free fall. Some pieces will ring with more resonance than others. Cast off those that have less to offer, and select the pieces that work well in terms of clarity of tone, volume and pitch relationships. Some driftwood rots and softens after long exposure to the elements, and other pieces may be waterlogged; these will probably sound dull. Some become dry and brittle, and produce a correspondingly bright sound. Others may be rich and mellow. Some pieces have checks, visible or concealed, which cause rattles and snaps and buzzes. In spite of these general expectations, many pieces will surprise you, revealing an acoustic personality you would not have guessed at based upon appearance.

When you have plenty of bars, begin assembling the instrument by laying the sounding bars across the two support pieces. To produce their best tone, each bar should rest on the support pieces at the nodes for the bar's fundamental mode of vibration. These are the points that don't move in the desired vibrational mode, but only pivot as the bar flexes. Resting the bars at these points will cause less damping than putting the point of contact at more vibrationally active points. For flat bars of uniform mass, rigidity and cross section size and shape, the nodes of the fundamental actually take the form of two nodal lines crossing the bar about 2/7 of the way in from each end. With natural driftwood bars such uniformity is unlikely, so for our purposes the 2/7 figure serves only as an approximation. You will find that if you lay a sounding bar across the supports in such a way that anything roughly approximating 2/7 of the bar length overhangs at the ends, the bar will show its voice if it has one. If it moves far from position you will notice the deterioration in tone.

Photo by Julian Shapiro

With the two support pieces laid out in their not-parallel arrangement, you can place a set of bars on them in graduated order from longest to shortest, in such a way that each bar lies where the supports are the right distance apart to give it about the right amount of overhang. Try laying a few out and sounding them; adjust their position or that of the supports if it seems to help. Try different combinations of bars for different scales or timbral qualities. Look for more or better bars if the need arises. Try different sticks as beaters; the mass and hardness of the beater makes a big difference in timbre and volume. Since the sounding bars are not fastened down, they'll dance around as you play, and inevitably get out of position after a while. Stop then, put them back, and play some more.

Any driftwood marimba you make will have its own musical personality, based in the peculiar set of pitch relationships, tone qualities and physical layout of the bars. It will give rise to its own characteristic music. The sound, especially in its native environment, can be very appealing.

COMPUTER CONTROL FOR ACOUSTIC INSTRUMENTS

By Bart Hopkin with Alec Bernstein & Alistair Riddell

(continued from page 1)

positional approaches; rather, they were generally used to reproduce existing repertoire and styles already associated with their hand-played counterparts. Music that appeared in player piano rolls was stylistically indistinguishable from piano music intended for human hands. Most, in fact, was recorded onto the rolls direct from human performances. The technique for punching piano rolls by hand was known and used, but little thought seems to have been given to the idea that one could hand punch music that was any different from what one might compose for a human player.* Decades later, Conlon Nancarrow recognized this possibility and exploited it to the fullest. In this, Nancarrow has been a pioneer in mechanical instruments for the current work in computer-controlled instruments.

The idea that one could create a better player piano using computer data storage technology and an electro-mechanical action surfaced in the late 1970s. Joseph Tushinsky, president of the Marantz company, set out to oversee the creation of a technologically advanced automatic piano. His idea was that performances from paper piano rolls (of which he himself had a fine collection) could be converted to the new medium. The result was the *Pianocorder*, originally introduced in 1978 and now no longer in production. The Pianocorder uses a set of solenoids to operate pistons, which in turn drive the hammer action of a conventional piano. Performance information for particular pieces is digitally encoded on a special cassette tape, and processed by a dedicated computer. Unlike the old player pianos, which (with some noteworthy exceptions) had in effect only "note on" and "note off" information, the Pianocorder also processes pedalling and dynamics codes, making for a far more refined performance. Two types of Pianocorder were made. One uses hardware installed inside the piano. The solenoid-activated pistons lift the back side of the piano key, and initiate the normal hammer action from there. The other sort simply mounts the row of pistons externally over the keys for normal playing. Hundreds of classic piano rolls, most of them originally made by famous piano players of early part of this century, have been transferred to tape for use in Pianocorders. The system also allows the user to record and play back his or her own performances.

The Marantz company sold its Pianocorder technology to Yamaha later in the 1980s. Yamaha did not keep the original Pianocorder in production, but took advantage of advancing technology to create a more sophisticated piano playing system, the *Disklavier*. The Disklavier action is built into a dedicated Yamaha upright or grand. For the grand, the computer is housed in a separate, free-standing console with a 3.5" floppy disk drive and control panel; in the upright these components are incorporated into the piano casing.

The entire system currently sells at prices ranging from about $7,000 for an upright to $26,000 for the largest grand. Within, the Disklavier mechanism uses solenoids much like those in the Pianocorder, activating the action by pushing up back side of the key. During recording of performances, the Disklavier reads the velocity of each keystroke (corresponding to volume) by measuring the hammer's travel time between two light sensors on the upstroke. The Disklavier incorporates a number of advanced features, including tempo control, volume control and transposition in playback; erasing, punching in and overdubbing in record mode; and various librarian functions for finding and keeping track of the pieces recorded to disk. It does all this through standard MIDI codes. This means that it can output to and accept input from synthesizers and computers. A sophisticated user has access to the instrument's control codes and, in theory, can manipulate and program them at will.

A growing library of pre-recorded Disklavier performances are available from several sources: Yamaha produces disks containing performances by well-known contemporary keyboardists in diverse styles, distributed by Hal Leonard. Several other vendors also produce disks of living artists, while QRS sells disk versions of classic player piano rolls.

The Kimball International company and Bösendorfer have also created a computer-controlled piano player system, housed in a Bösendorfer grand. A library of recorded music is available for it in several formats, and it has record features as well. At $110,000 – 160,000, high cost has prevented its widespread use. Several other vendors have created conversion systems for standard pianos, including Piano Midi-Matic, PianoDisc and QRS Pianomation.

By making it possible for users to make their own recordings, Marantz brought its Pianocorder one very large step beyond the player piano. But in other respects the manufacturer appears to have been thinking along traditional player piano lines. In particular, the Marantz people don't seem to have followed Conlon Nancarrow's conceptual step – although they created an ideal instrument for it – in seeking to realize the possibilities for a piano that is programmable outside of real time, with the potential for musical idioms distinct from human-hands pianitude. With the advent of the MIDIfied Disklavier, the programmable piano has now become commercially available.

But let us take a step back. To introduce the composers and builders whose work is described in the following pages, we must return to the post-Pianocorder, pre-Disklavier era. At that time, several astute musicians – members all of *the honorable legion of underfunded tinkerers* – recognized the potential for computer programmable piano, implicit but not realized in the Pianocorder. Independently and generally unaware of one another, they began to work with modified Pianocorders and Pianocorder parts. The key in making a user-programmable instrument was the creation of accessible computer interfaces, through which the composer could directly input or manipulate the performance information codes that control the electro-mechanical action. (The only way to input performance information in the standard Pianocorder, remember, was to record real-time keyboard playing.) By linking the Pianocorder to a separate microcomputer and creating the requisite software, it became possible, Nancarrow-style, to pre-program entire pieces that might be

* There were exceptions to this rule, even before Conlon Nancarrow. Stravinsky, writing in **Current Opinion** in 1925, spoke of new possibilities implicit in the player piano, and suggested that they would in time be recognized.

otherwise unplayable. Further, all manner of other computer-controlled musical behaviors could be generated: real time interaction with a human player, for instance; or performance of diverse operations on real time input (time delays, transpositions, inversions, retrogradations and more esoteric functions); or re-direction of output to multiple instruments.

One of the first to create a computer interface for the Pianocorder was composer Richard Teitelbaum, working with computer systems designer Mark Bernard. In 1982 he created a system using three computers and three Pianocorders playing three grand pianos. The system can encode performance information from a human player at one piano, store and/or manipulate it digitally, and send the manipulated data to either or both of the other pianos for playback, all in real time. It has more recently been made MIDI-compatible. The control language developed by Bernard and Teitelbaum, Patch Control Language, is designed in a modular fashion, using sub-units each comprising a command set. These sets are designed to make it easy for a composer or performer (even one new to the system) to create sets of customized performance parameters for a given composition or performance. In 1986 Richard Teitelbaum made a record, **Blends and the Digital Piano**, using this system, and he has continued to develop and record with it since.

Peter Zinovieff used Pianocorders and computers in several different ways, also in the early 1980s. Perhaps most interesting was a system designed to transcribe common sounds into patterns of notes amounting to a pianistic analog of the original.

Trimpin, a native German living in Seattle, in 1980 developed his own system instrument player system using velocity-controlled solenoids driven by a TRS-80 computer. In 1985 he modified the system to make it MIDI compatible. In addition to pressing piano keys, he has solenoids and pistons sounding drums and other percussion instruments, strings, winds and found objects. At a recent demonstration in San Francisco he used garbage cans and their lids, these being chosen simply because they were conveniently on hand and available at the site. Trimpin has specialized in creating environments of sound events dispersed within a space and minutely controlled in time. Sounds arise in rapid succession from sources located around a room, creating a strange and exhilarating sense of motion.

We turn now to a closer look at the work of three more Pianocorder experimentalists, the team of Alec Bernstein and Danial Carney, and Alistair Riddell.

Alec Bernstein and Danial Carney

Alec Bernstein and Daniel Carney, working together under the name **Aesthetic Research Ensemble**, have created a number of computer-controlled instrument playing devices. At present these include players for piano, marimba and xylophone, timbales, roto toms and log drums. All are based in Pianocorder technology, using original Pianocorder parts extensively, but the software and many aspects of the hardware have been reworked. Bernstein designed new electronic controls and computer interfaces to replace the Pianocorder's tape cassette digital performance information encoding system. Dan Carney wrote software for computer control of the system.

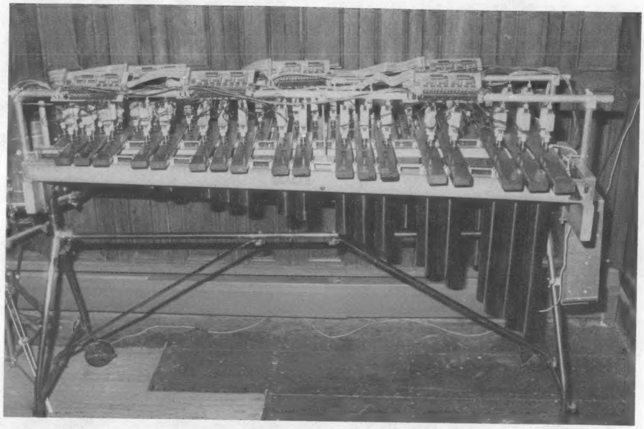
The automatic piano player developed by Daniel Carney and Alex Bernstein of Aesthetic Research.

The piano player shown here can be affixed to any standard piano keyboard. The hardware consists of a bank of eighty solenoids, each controlling a key-pushing piston aligned with one of the piano keys. There is an additional lever below for pedaling. The composer/programmer dictates pitches and durations, and can control tempi, dynamics and legato as well. The software is, in effect, a score editor at the same time, including transposition functions. The user can program entire pieces in advance, or may choose to manipulate performance elements in real time from the computer terminal. These can include dynamics, tempi, the sequence of different musical passages, retrogradation, transposition and more: for their own performances, Bernstein and Carney have evolved over a hundred parameters for integrating real-time performance with computer control.

An intriguing sidelight to this and many other piano playing systems: the moving arms and fingers of a human piano player

tend to obscure the actual keyboard action from view. Absent them, and, as with some of the old player pianos, we suddenly see the music reflected in roving patterns of key movement. Seeing and simultaneously hearing musical patterns in this way turns out to be strangely fascinating.

The marimba player uses a piston action similar to that of the piano player. In the photograph here it is set up on a classic 1927 Deagan marimba. There are two pistons for each bar to allow for faster tremolos and a fuller double-struck fortissimo.



Solenoid-controlled 1927 Deagan Marimba, by Aesthetic Research

The playing systems for other instruments (vibes, timbales, log drums) follow the same principles as those described here for piano and marimba, with just a few modifications: The system for the longer-sustaining vibraphone includes computer-controlled individual dampers for each note. The timbales have two beaters near the center and two near the edge to provide timbral variation. The optimal duration of contact time between beater and sounding surface differs from one instrument to the next, and some experimentation has gone into fine tuning it in each case. The piano action is relatively slow (about 20 milliseconds between the initial key-pressing impulse and the onset of the sound, as opposed to the virtually instantaneous onset for the direct percussion instruments), so some subtle compensation in the instructions to the computer has been required to bring the instruments in line for ensemble playing. (This consideration fills one with admiration for the *human* computer, by which pianists correct for the delay without even being aware of it!)

The software can control multiple instruments, so that piano, mallet percussion and drums can play, computer controlled, in ensemble.

Solenoid-controlled timbales (below) and tube drums (above), from Aesthetic Research.

Alistair Riddell

Alistair Riddell began work with a Pianocorder-based piano playing system in 1981, with the intention of exploring some of Conlon Nancarrow's ideas, particularly those found in *Study #25*. He has more recently been working on a third-generation system called Meta-Action, not yet in full operation. The second-generation system explored certain mechanical and technological aspects of interfacing computer technology to the acoustic piano. This project included two instruments. One was simply a traditional upright instrument with the Pianocorder mechanism installed, while the other was a modified player piano with the keyboard and action removed. Replacing these components was a simple action of solenoids. The Meta-Action project has taken this approach to a more technically advanced level. The project was a two year long development of an action for the grand piano, not, as in the previous project, an action for the upright instrument.

Since the grand piano keyboard and action assembly is normally a unit that is fairly easily removed, Riddell concluded that it is easier to simply replace them with a direct electromechanical hammer mechanism than to design yet another mechanism that works through the existing action. Thus, while other piano playing systems work in conjunction with the original piano action, Riddell's unit replaces the piano action entirely. The solenoid pistons themselves, with extension rods and padded tips, strike the strings directly. The entire system is made as adjustable and modular as possible, to allow it to be accommodated by different pianos – a challenging task, given the peculiar shapes and limitations of the space available within the action chamber. In the Meta-Action, the solenoids are mounted on a rail and can slide into any position for different string arrangements and spacings.

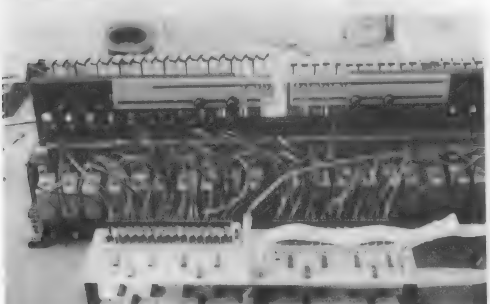
With the standard action entirely removed, Riddell's system

connects to the existing damper mechanism. For each string there are only four moving action parts: the hammer solenoid and the damper solenoid, the lever which lifts the damper, and the damper itself (there are two parts to the damper itself). The action therefore has a much higher operational speed. In standard pianos, damper action is tied to the hammer action: when the key is depressed, the hammer is set in motion and the damper lifts. It stays away from the string until the key is released. However, in the Meta-Action the dampers are under autonomous control. Their operation can be synchronized with the hammers or completely independent. In the previous generation of the system it proved to be too difficult to to have independent damper control for each string, so two large damper bars, each covering many strings, were employed. However, since the solenoid/hammers were a single moving part they could be activated at a much faster rate and this proved to be an interesting technique which was explored in "Atlantic Fears" (1983). With fully independent damper control, different sonorities become possible through creative use of the dampers: in addition to simply leaving them on the string when the hammer strikes, one can exploit the effects of subtle variations in hammer and damper timing.

Pianos set up for use with an earlier computer-controlled piano playing sysem created by Alistair Riddell

Since there are 88 hammer solenoids and approximately 70 damper solenoids, the task of individual control for each is fairly demanding. Although some dedicated processing technology will be required to achieve acceptable autonomous control, Riddell foresees that MIDI will play some role in the communication between the performer or performance system and the instrument. His current thinking about the action is as part of a Performer/Machine interactive system, in some respects returning the performer to the instrument through technology.

Above and below: elements of the system currently in development by Alistair Riddell.



Alec Bernstein and Daniel Carney, performing under the name Aesthetic Research, present their computer-controlled instruments on cassettes available for $7 each from Alec Bernstein at 846 Tyson St., Baltimore, MD 21201; phone (301) 728-4673. For more information, contact Alec directly at the same address.

Alistair Riddell's computer-controlled piano player can be heard on two CDs: the piece "Atlantic Fears" appears on **Anthology of Australian Music on CD**, CD #4 (from School of Music, Canberra Institute of the Arts), and "Fantasie" appears on the newly released **Austral Voices** (New Albion, 584 Castro St. #515, San Francisco, CA 94114). NMA Publications (PO Box 185, Brunswick, Victoria 3056, Australia) has released NMA tape #1 containing two works from an earlier piano player system, and NMA tape #6, with an improvisation from Riddell's second generation system. No recordings of the Meta-Action piano player system are yet available.

Richard Teitelbaum's computer-controlled piano player system can be heard on "Concerto Grosso", available on CD from Hat Art in Switzerland, and "Run Some By You" coming soon on CD from Wergo Records on the CCRMA Stanford University Digital Music series.

An exhibit of reproducing pianos, ranging from player pianos to computer controlled instruments, will reopen around the end of July 1991 at the Smithsonian Institution in Washington, DC. Call 202/357-2627 for information.

Acknowledgements:

Most of the information in this article was provided by Alec Bernstein and Alistair Riddell, in conversation and through written materials. Alistair Riddell's master's thesis **A Perspective on the Acoustic Piano as a Performance Medium Under Machine Control** was particularly helpful for the background and overview it provided. Additional information was provided by Trimpin, Richard Teitelbaum, Carter Schuld and Lloyd Whitcomb of Yamaha Corporation of America, and Todd Ernhard at G. Leuenberger pianos in San Francisco. Thanks to all.

CONJOINED STRING SYSTEMS: REPORTS FROM BUILDERS

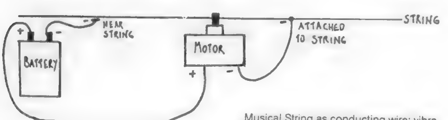
by Mario Van Horrik and Paul Panhuysen

In the last issue of Experimental Musical Instruments we presented an article called "Conjoined String Systems". It discussed what happens acoustically when sets of two or more musical strings, rather than being anchored separately, are attached directly to one another, creating multiple-string vibrating systems. This unorthodox idea produces, as you might expect, unorthodox musical results — but unorthodox in ways that can be quite intriguing, and even sometimes rather beautiful. In this follow-up article, we present first-hand reports from Mario van Horrik and Paul Panhuysen, two builders who have explored such methods in connection with very long string scale. In the coming August issue we will conclude with accounts from Jeff Kassell, Tom Nunn and Bart Hopkin, who have worked in conjoined string systems at standard string lengths to produce more conventionally playable instruments.

Mario Van Horrik
MULTI-FUNCTIONAL STRINGS

Mario van Horrik is a sound artist living and working in Eindhoven, the Netherlands.

I work with the elements sound, movement and image, all in the widest meaning of the words. Strings are the basic attribute in my work, and I use them in many different ways, combinations and constructions. I use them because of their own sound; as vibration-transporters between other materials (to 'mix' frequencies and soundcolors of diverse materials); or as 'drivers' for other strings and/or materials. Sometimes I use them with a double function: for instance, the strings are used to transport an electric current, while the vibrations of that same string alternately open and close the circuit which contains the device (e.g. motor) that makes the string vibrate (which makes it a kind of feed-back-system).



Musical String as conducting wire: vibration of the string intermittantly completes the circuit which includes the motor that drives the string.

In the last three years, three pieces I made are significant for the interconnecting or 'driver' function of strings, each in a different way.

1. The Boxing-Ring (1987).

Construction:

From the floor to the ceiling, in a square, four strings are tensed. At certain heights, a metal ring is put on each string. Horizontally, nylon rope connects the metal rings. So the basic construction resembles a boxing-ring. The strings are amplified by means of piezo transducers, attached to the string with wooden clothes-pegs. From three of the metal rings, cross-strings extend away from the boxing-ring. On two of them, metal staves hang; on the other a jerry-can filled with water. On the fourth string, near the floor, an electric razor is taped.

Performance:

The Boxing-Ring is played by me as a musician from outside the construction. From inside the rope square, it is performed by the dancer, Petra Dubach. During the performance, I play the metal with sticks and rub them with rubber balls; play the strings with bow and hands (pluck and damp); sing against a metal ring and inside the jerry-can; shake the jerry-can to make the water sound, and turn on and off the electric razor.

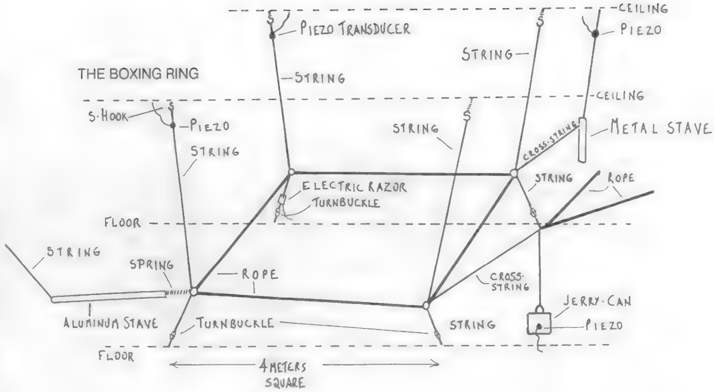
Petra walks along the ropes producing a roary sound, and pulls the rope towards herself and lets it loose suddenly to cause an explosive sound. She rubs the rope, pulls it, hangs over it with her body, balances while holding the rope, pushes it away. In this way, she tunes the sounds produced by me or the electric razor. Her energy becomes audible; if she pulls hard, the sounds change faster and get a higher pitch than when she pulls a little.

What Happens:

Any sound produced is picked up by 4 piezo-transducers, which 'blow-up' the sounds that are in fact acoustically inaudible. The ropes function as a filter, mainly cutting the high

Dancer Petra Dubach performs in the Boxing Ring.

THE BOXING RING



frequencies. Another factor is the different lengths and thicknesses of the strings used.

The piezo nearest to the place where the sounds are being produced picks up the sound the most clearly and loudly. It has its own frequency, which mixes with the 'input' frequency, and that of the transporting cross-string. The result is a very complex sound, made even more complex because there are three more piezos picking up the same vibrations, softer but far more complex because of the longer route the vibrations have to take to reach them, running through rope, strings, metal rings, cross-strings, etc. Add to this the influence of the dancer, who adds her own sounds to it, and who changes the frequencies of all strings just by pulling a rope. In one scene of the piece, when the electric razor is on, Petra makes a round along the ropes, pulling them gently, leaning over them, pulling two ropes at a time in a corner, etc. She works very subtly and gently. In this scene, up to five layers of overtones are audible, each layer changing in its own tempo.

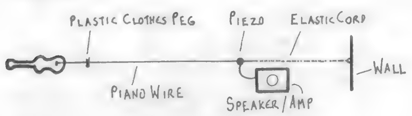
2. Flexitar (1988)

Basic Construction:

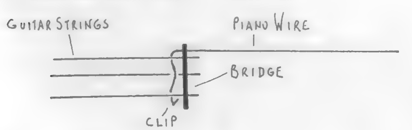
Through three strings of a guitar, a long piano-wire is woven, extending away from the guitarist. The long string is lengthened with elastic chord, which in turn is attached to, for instance, a wall. At the end of the long string, a piezo is attached with a wooden clothes-peg. Somewhere near the guitar, a small plastic clothes-peg is put on the long string.

FLEXITAR

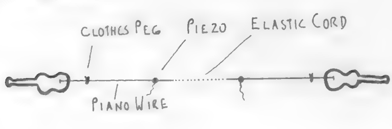
A:. Basic setting



B: Transmission guitar strings –> piano wire.



C: Two guitarists.



What Happens:

The player plays the guitar strings, and the strings' vibrations are 'fed' into the long string. The transverse vibrations of the guitar strings convert to longitudinal vibrations in the piano-wire, so there's not much tension needed to let the piano-wire sound. The frequencies of the guitar strings mix with the two basic frequencies of the piano-wire (the piano-wire being divided by the plastic clothes-peg). The result is a very complex sound with many overtones. The overtone structures can be changed by the player by changing tempo in his beats, by tuning with the tuning-pegs, placing fingers on the fingerboard, and by moving in the space, making use of the elastic chord. The first three techniques influence the 'input;' the fourth changes the tension of the piano-wire.

So the guitar is the 'driver' of the piano-wire, while the guitarist changes the overtone structure by walking a bit, or merely changing weight from one leg to the other.

Performance Possibilities:

The basic construction has a lot of possibilities. Some I used are:

A. To play with 2 guitarists. Setting: guitar-string-elastic-string-guitar. The players influence each other's sound by moving.

B. Four guitars: a ring in the middle, on which 4 elastic chords end. Guitarists in positions north, east, south, west.

C. Other 'drivers': trombone, string, elastic. Metal plate, string, elastic, etc.

D. Combination with a dancer: guitar-string-elastic-dancer-elastic-string-guitar. The guitarists stand as steady as possible. The dancer holds the ends of the elastic chords in her hands, and moves with the arms, causing the changes in the sounds. In fact, her role is that of the 'real' musician, because her ears conduct her movements.

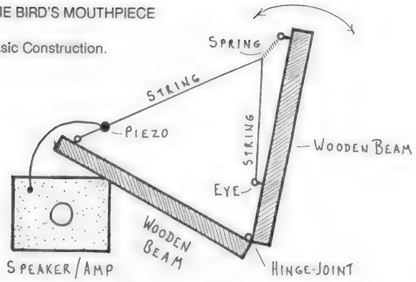
3. The Bird's Mouth Piece (1990).

Basic Construction:

The instrument consists of two small wooden beams,

THE BIRD'S MOUTHPIECE

Basic Construction.



connected by a hinge-joint. There is one laying and one standing beam. From a metal eye, screwed half-way in the standing beam, a string runs up, goes through the eye of a spring (attached to the top of the beam) and ends at an eye screwed in the end of the laying beam. Near the place where the string ends at the laying beam, a piezo is fastened. Further construction possibilities include cross-strings, ending at diverse materials or a wall; or other strings attached at any point of the wood, eyes or string, and amplified by separate pick-ups or whatsoever.

How It Functions:

The Bird's Mouth instrument is plugged into a small guitar amp/speaker combination, with the volume turned up to a certain point. The laying beam is placed on the amp with the hinged end resting on the floor, while the standing beam is held (by someone or something). The instrument will produce feed-back-sounds that can be altered by pushing or pulling the standing beam. Because of the spring, the string changes tension and starts to feed-back at a different frequency. It is also possible to produce whale-like glissandi.

What Happens:

The feed-back results from the direct contact between instrument and speaker. The string starts to vibrate, also setting cross-strings with connected materials into vibration. In this way, the feed-backing string is the 'driver' for one or more other strings. It is possible to enlarge the setting to the likeness of a gigantic spider web of strings, all driven by one feed-backing string that constantly changes and glides.

Bird's Mouthpieces (sans amplifiers)

Paul Panhuysen
LONG STRINGS

Paul Panhuysen is director of Het Apollohuis, a center for the arts in Eindhoven, the Netherlands. In collaboration with Johan Goedhart, he has worked extensively with sounding installations using very long strings in large architectural spaces.

What interests me in multiple-string systems is the opportunity to play indirectly, using one string to play the others connected to it. Indeed, the **Pillar Koto** (Frankfurt, 1982) was the first long string installation which worked as a multiple-string system. It was also the second installation with long strings we ever made. Relating our installations always to the architecture, and conceiving our instruments as visual works of art in the first place, multiple-string systems have been very often a kind of natural result of our attitude towards the spaces we were working in. Symmetry occurs regularly in architecture and sometimes makes it unavoidable that long strings which cross will hit each other. At first, I considered this just as a problem, since sounding these strings produced incredible and unpredictable rattles. To get a little control, I put small perforated wooden blocks on crossing strings. After moving them to the crossing point, I connected them together (with adhesive tape, later with small wood-clamps). Since the strings move freely in these blocks, it allows tuning of the whole string. After tuning, it is possible to fix the strings with wedges. Doing this I obtained an instrument which allows one to play on one string and make the other strings of the system sound. Amplifying only the latter ones produces a very rich pattern of overtones.

A piece we perform with Maciunas Ensemble, conceived by Mario van Horrik, is based on this principle. The four musicians each play on an unamplified electric guitar; at the end of one or more strings of each guitar a long thin steel string is connected. At the end of this string a piezo-pickup is attached, and a rubber band to stretch the string more or less while we are playing. The end of the rubber band is fixed to the wall. The length of the long strings varies between 9 and 12 meters. In performing this piece, we play on an open string of the guitars and amplify only the long strings. Some pegs on the long strings adjust the character of the sounds.

Recently, I developed a type of acoustical long string installation, which may be considered as a multiple-string system. A paint can, acting as a resonator, is attached part way along a horizontal long string. A second paint can is attached part way along a vertical long string, coming down from a connection point on the horizontal string, and anchored to the ground below. Both cans are equidistant from the conjunction of the strings. I found that when the horizontal string is set in vibration by means of an electromagnet, sounds are produced which are alternately amplified by one of the two cans.

This is a very intriguing acoustical phenomenon, very spatial. I think that the can on the perpendicular string is rendering the transverse vibrations. The vibrations produced on strings must be always a combination of transverse and longitudinal vibrations in changing degrees.

There is certainly much more to tell about my experiences with multiple-string systems. Tuning for the long string installations is always based on measuring, calculus or mathematics. We use just intonation or architectural scales, my favorite tuning system nowadays being a pentatonic scale (N1; N2 = N1 + 1/3 N1; N3 = N2 - 1/3 N2; N4 = N3 + 1/3 N3; N5 =

N4 - 1/3 N4); N1 being the length of the first string. There is also a kind of minor scale (N1; N2 = N1 - 1/3 N1; N3 = N2 + 1/3 N2; N4 = N3 - 1/3 N3; N5 = N4 + 1/3 N4).

Before I worked a lot with magic squares, golden dissections, and so on. Tuning systems based on measurement are, of course, much easier to apply on multiple-string systems. One can make drawings and designs beforehand and do finer tuning later on the instruments, with tuning pegs.

Credits for Mario van Horrik's section::

Photographs of "The Boxing-Ring" taken by Tom Veeger.

Photograph of the "Bird's Mouth Piece" taken by Marijke Spekman.

"The Boxing-Ring" is performed by Petra Dubach and Mario van Horrik under the name 'Antarctica.'

"Flexitar" is performed in different versions by Mario van Horrik solo; together with Petra Dubach, Flexatone (Flexatone is Paul Verwilligen and Mario van Horrik; sometimes with Petra Dubach), and the 'Maciunas Ensemble' (Paul Panhuysen, Jan van Riet, Leon van Noorden, Mario van Horrik).

Drawings and text by Mario van Horrik.

"CHANCE" — Long string installation by Paul Panhuysen and Johan Goedhart, 1989.

A DAY IN THE PATENT LIBRARY

By Bart Hopkin

EMI's last issue contained an article entitled "Patenting for Musical Instruments", addressing the question of whether it makes sense for creators of new musical instruments to seek patents on their designs. What follows here is a sidelight to that same topic — a report on some interesting musical instrument design ideas encountered in the course of the author's informal patent search.

Some readers may recall that in EMI's August 1988 issue (Volume IV #2) there was an article about an instrument made by the author of this article, a glissando clarinet which I call Bentwood Chalumeau. It uses a simple but effective pitch control system which allows for continuously variable pitch over the full two octave range, without register changes. After that article appeared, several people said to me something that I'm sure other instrument inventers hear now and then "You ought to patent that thing." One who said that was Barbara Robben, and she added "if it doesn't work out, you could use the experience to write a good article for EMI." That idea appealed to me, and I decided to look into the matter.

I began to do some reading about patenting, first in a book that Barbara loaned me, and later in other sources. I learned where the nearest patent library was (way the heck down in the South Bay) and set aside a day to make my pilgramage.

On the appointed day, I spent several hours nosing around in the patent library, and I could happily have spent much more. My official purpose, of course, was to ascertain whether any patents had already been granted on my idea, so let me review the idea now. It is a continuously variable pitch control system for wind instruments that are not compatable with trombone or slide whistle slides (for various reasons, many wind instrument types are not). The instrument's tube has a long slit, about a half inch wide, running from the distal end to a point just short of the near end where the mouthpiece joins. A narrow, flat, flexible, bent strip of material is attached at the mouthpiece end of the slit. It would cover the slit but for the fact that it curves up and away. Pressing the flexible strip down causes it to cover more and more of the slit, progressively increasing the sounding length of the tube and thus varying the pitch.

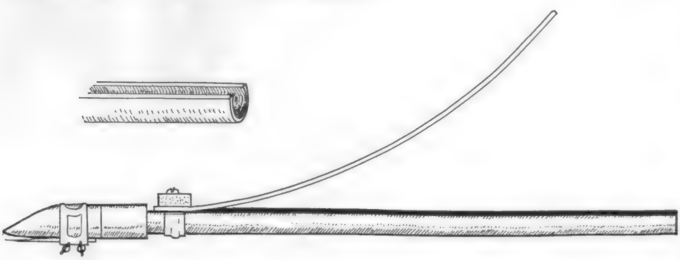
In the library, I soon found that the patent office's taxonomic system, for all its detail and careful cross referencing, did not allow me to very effectively narrow down the list of possible related patents. It didn't categorize things in such a way that I could isolate pitch control mechanisms for generalized wind instruments under a single heading. This meant that I was going to have to examine a great number of patents relating to wind instruments, the majority of which would be irrelevant.

With a certain amount of bungling around and pestering the librarian, I slowly learned how to locate the relevant patents. In the course of the day I reviewed about a zillion ideas for wind instrument design improvements. Some were useful, if not dramatic, alterations in things like bore shape or flute blow hole cover arrangement. Others were radical and sometimes frivolous schemes for unlikely things like hybrid or multiple instruments. I succeeded in tracking down several methods for continuous pitch control in wind instruments, including some very ingenious ones.

Did I find anything resembling my slit-and-tongue arrangement? Yes. In patent #4,320,686, granted to Jeffrey J. Lewis of Los Angeles on March 23, 1982, I found something similar enough to make me believe that a patent on my instrument would be denied. I'll go farther and add that his "preferred embodiment" is probably superior to mine.*

So that was that. Some time later I wrote to Jeffrey J. Lewis at the address given on the patent. The letter said, I'd like to tell EMI's readers about your patent — would you like some input in the process? Since the address was nearly eight years old by then, I also went through telephone information to try to track him down, and actually called a few possible Jeffrey Lewis's in LA. None turned out to be my man. Nor have I had any response to the letter.

Patent #4,320,626 is, like all patents, public information, and I am free to publish it even though I was unable to reach the patent-holder. And so I take pleasure in presenting parts of it here — but with this important word: This patent is in effect at this time. It is illegal for unlicensed parties to use,



The author's Bentwood Chalumeau. The inset shows the end of the tube and the longitudinal slit. The heavy line along the top of the slit seen in the side view represents strips of adhesive-backed foam rubber running on each side of the slit, to insure a good seal when the bentwood is pressed down.

* Given that the Lewis patent might make my invention unpatentable, the question still remains whether Jeffrey J. Lewis could legally prevent me from manufacturing or selling it. Larry Johnson, a patent attorney who reviewed this article prior to publication, observes that one should not be "too quick to conclude that a given invention infinges on a patent: such a determination is better made after a thorough analysis of the claims of the issued patent, a review of the file history, and other matters. However, since it can be very expensive to undertake such an analysis, a decision to forego a potentially infringing invention may in fact be a more practical decision."

manufacture or sell this invention; and given that Mr. Lewis went to considerable pains to protect his idea from unauthorized use, it is also clearly unethical. I trust EMI's readers will respect this.

I also will reprint here two more wonderfully clever continuous pitch control systems for wind instruments that I found in my search that day. These, being from 1957 and 1933 respectively, are no longer in force.

WIND INSTRUMENT WITH CONTINUOUSLY VARIABLE PITCH CONTROL

Patent #4,320,686, March 23, 1982,
Jeffrey J. Lewis.

Here are Jeffrey J. Lewis' drawings of his sliding pitch wind instrument, shown alternatively as a transverse flute and a clarinet. A glance at the isometric drawing Fig. 6 makes it easier to read the others. Notice the open slit (56) running the length of the sounding tube, with the flexible strip (58) raised above it. When the player presses the strip down over the slit with a finger (49 in Fig. 3), the portion of the slit on the mouthpiece side of the finger will be closed, effectively lengthening the air column and lowering the pitch.

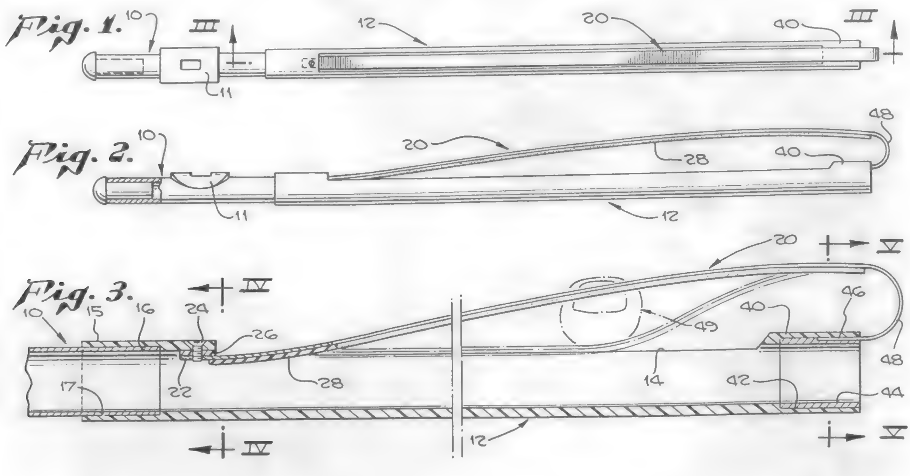
Where my own instrument, Bentwood Chalumeau, had a flexible strip which was free at the far end, curving up and away from the tube, Lewis's arrangement uses a strip anchored at the far end. Beyond that, there are few differences between the two designs, and it is easy to see why I concluded that Mr. Lewis' prior patent does indeed cover my idea.

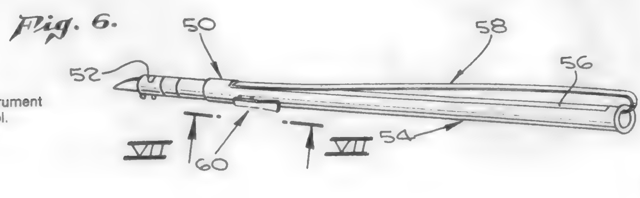
WIND INSTRUMENT WITH HELICAL FREQUENCY DETERMINING MEANS

Patent #2,806,399, Sept. 17, 1957
John W. McBride

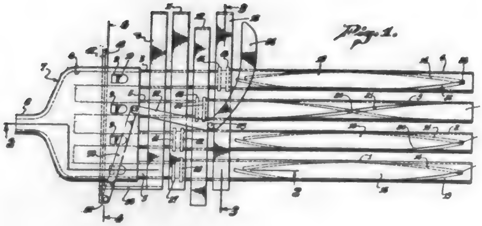
This patent contains three pages of drawings showing what the inventor regarded as a single concept in several different applications. These included single wind instruments as well as instruments with multiple tubes, and sliding pitch instruments as well as more or less discrete pitch versions. Mr. McBride's idea in its most basic form is this: A continuous open slit running the length of a sounding tube can be progressively covered or uncovered by the rotating motion of an outer tube also containing a slit. The trick is in the fact that one or both of the slits is helical – that is, it spirals part way around the tube as it runs the length. As a result, the two slits cross to create an opening in the tube at a single point, and this opening point moves up and down the column as one tube is rotated relative to the other. In some cases McBride has replaced the slit with individual holes arranged helically on one of the tubes, in order to create a discrete, rather than sliding pitch instrument.

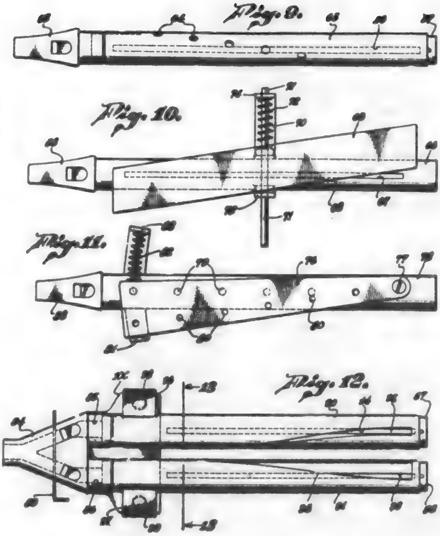
(Drawings for the McBride patent are overleaf)





Drawings for Jeffrey J. Lewis' Wind Instrument with Continuously Variable Pitch Control.



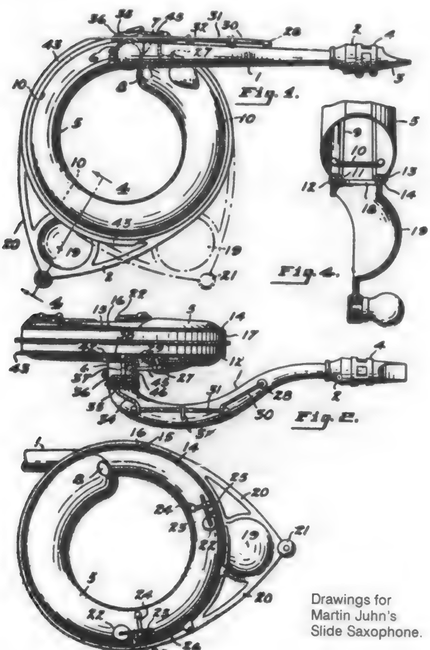


Above and right: Drawings for J. W. McBride's Wind Musical Instrument with Helical Frequency Determining Means

SLIDE SAXOPHONE

Patent #1,895,761, Jan.31, 1933
Martin Juhn

Over the years I have often heard tell of a slide saxophone, but I have had difficulty locating anything beyond the most superficial information on it. Thanks to the latest installment of Lloyd Farrar's "Under the Crown & Eagle" in the **Newsletter of the American Musical Instruments Society** (Feb. 1991), I have just recently learned the patent number for the legendary slide sax. (It was U.S. Pat. No. 1,497,939, June 17, 1929).



Drawings for Martin Juhn's Slide Saxophone.

I've not had the opportunity to obtain a copy of that patent, and so can say little about it at this time. What I have to show instead is drawings from the patent for *another* slide sax that I happened to stumble across, dated four years later.

As with the helical instrument above, these drawings are a little hard to interpret without some study. You can orient yourself by looking at Fig. 2, and considering that the large flat section on the left is actually a side view of the circular section of the tube seen in the other drawings. In effect what you have is a conical bore tube configured so that second half of its length forms as nearly complete a circle as possible. This means there is a 90 degree bend at the point where the pipe leading from the mouthpiece enters the circular section; the remainder of the pipe then circles around and stops just short of where it would otherwise meet that bend. Notice in Fig. 3 that there is no bell at the end of the tube. The bell is the cavity (19) visible in Figs. 1 & 3. Are you beginning to get the picture? Once again we have a slit (9) running the length of the circular section of the tube. Alongside the slit are tracks on which a flexible covering for the slit rides. At some point along the slit covering is an opening, leading into the bell. The track is designed so that the player can rotate the slit cover, and with it the opening and bell, full circle. The opening might start at the beginning of the circular section of the tube, slide its way around, making the vibrating length of the tube progressively longer, and eventually slide past the end to return to the starting position. If the circular portion of the tube represents one half its total length, one circumference then corresponds to the octave and the return can correspond to a register change and a continuation of the glissando.

HET APOLLOHUIS 1985-1990

Paul Panhuysen, editor

Published in 1991 by Het Apollohuis, Tongelresestraat 81 5613 DB Eindhoven, The Netherlands. Written in English.

Reviewed by Bart Hopkin

Het Apollohuis is a venue for artistic exploration founded by Paul Panhuysen in Eindhoven, The Netherlands in 1980. Artists in diverse disciplines from around the world have stopped there to present work and conduct research. In 1986 Het Apollohuis published **Het Apollohuis 1980-1985**, a retrospective catalog of exhibits and performances that had taken place in the space since its inception. Now, with another half-decade past, **Het Apollohuis 1985-1990** has appeared as a follow-up volume. Over these last five years, Het Apollohuis has presented 102 installations and exhibits, and 163 concerts, representing almost 400 artists. The great majority of this new book is given over to documenting those events in hundreds of black and white photographs accompanied by brief descriptive texts.

Sound art, in countless diverse forms, has always been central at Het Apollohuis. Well over half of the events documented here entail sound work. Most of them involve some sort of exploration into the physical nature of sound. In his opening essay, Janny Donker observes that "The 'new music' presented at Het Apollohuis is concerned with a return to the basic data of acoustics: the production of sound by whatever materials are capable of setting the air to vibrating."

So long is the list of artists whose work appears here that their names fill two pages at the back of the book. Many are well-known in new music circles; just as importantly, many are not, including some of the most interesting. Somewhat arbitrarily, I pick out a few to highlight here:

In November of 1985 the German artist Gunter Demnig presented a sound installation called *Infraschall*, including several performances. A photograph in the book shows a central upright structure with perhaps 15 large diameter flexible corrugated tubes protruding. The tubes snake out across the floor like mangrove roots, taking over the entire exhibition space, and terminating in variously shaped casings, contents unknown. The brief notes read "The installation *Infraschall* consists of a number of elements that are connected by tubes to an air compressor. Gunter Demnig performs on the installation by opening and closing the valves in the tubes, thus changing the pressure and the pitch."

In June of 1986 Rolf Langebartels created his *Table Concert*." The photograph shows a group of attentive-looking people sitting around a table as at a quilting bee, except that each person has before him or her on the table a number of small objects, some obviously musical and some not. A computer terminal sits at one end of the table. The notes read, "The computer instructs the performers when to start playing. The participants each play their own objects and instruments."

In December of 1987, Nicolas Collins created two installations called *Killed in a Bar* and *Under the sun II*. "The strings of a guitar are vibrated by the signal from a transistor radio. The resulting sound is amplified with pickups at the strings and reproduced through a small loudspeaker system. A toy train on a track runs at an overhead wire, which is used as a string. The string is vibrated automatically and its sound is amplified. The location of the train dictates the pitch." The photo shows a very large room, bare but for a guitar and small amp at the far end, and the single straight toy train track, with train in mid-course, running the diagonal.

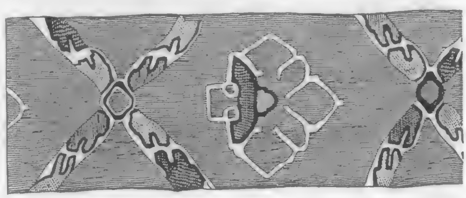
Around the same time Pierre Bastien exhibited his *Mécanium*, using parts from the children's metal construction kits called Meccano: "Pierre Bastien constructs musical automatons from meccano parts and instruments like bells, drums, percussion woods. The automatons are driven by electro motors and play rhythmic repetitive music." The photograph shows an oddly pretty, small-scale industrial-looking tower laden with pulleys and moving parts, bells and beaters and other noisemakers.

In February of 1988 Nico Parlevliet presented *Timbre Variable*. The photograph shows several things looking like large, squishy rocks with tongues, connected by air hoses and arranged around the floor of a dimly-lit room. "Nico Parlevliet made an installation of six differently-shaped air bags with one or more horns protruding, and with sensors. When a person passes by, each bag reacts in its own way by inflating itself and producing a whistling or organ-like tone."

In May of 1989 Ron Kuivila presented *Spark Harp*, "an installation with six stretched parallel high voltage wires, between which sparks are generated at random in different spots. The wires are used as strings, played by the sparks, and the sound is amplified by means of a contact microphone."

In March of 1990, Mark Laiosa presented a concert under the title *Triangle Music*. "Mark Laiosa explores the sound spectrum of the triangle. He plays with different rhythms and uses diverse materials to strike the instrument. By flinging the triangle around he produces vibrating sounds in the room."

Het Apollohuis 1985-1990 is one of several books, artist's prints and recordings produced in limited editions by Het Apollohuis, all of them well crafted productions. Another of them **was Echo: The Images of Sound**, reviewed in this space a while back (EMI Vol. IV #5, Feb. 1989). It documented a months-long gathering of sound artists at Het Apollohuis in 1985, with essays and additional appendices as well as photographs and accompanying notes. A second **Echo** festival took place at Het Apollohuis in 1987 and there has been talk of an **Echo II** book appearing soon. In a field in which documentation tends to be scanty, Het Apollohuis continues to play a leading role as a presenting organization, a research center and a publisher.



Editor's Report

STILL LOOKING FORWARD

by Bart Hopkin

With this issue **Experimental Musical Instruments** begins its seventh year of publication. Each year at this time I, the editor, report on how we are getting along.

The biggest change over the last year has been our conversion to desktop publishing methods. That has altered the look of the journal somewhat, but doesn't much affect our purpose and spirit. The subject matter and editorial orientation remain what they always have been, and just because it doesn't hurt to be clear about this, I'll repeat a formulation that I used in this same column a couple of years ago. EMI is interested in the great diversity of possible approaches to acoustic and electroacoustic musical sound making, with an emphasis on the unusual, the ingenious and the inventive methods that can open up wider possibilities for creative musicians – and, for that matter (it occurs to me now to add), and for anyone else.

I continue to be grateful for EMI's greatest asset, the ever-growing and changing pool of generous people who contribute their articles, artwork, ideas and time. The majority of those people are simply ones who had something to share and were interested enough to do so. EMI will always keep the door open for these things.

Some reminders for our readers:

I love getting letters to the editor. Others love reading them. Those first few pages of each issue are always full of interesting things. If you've got something to say, write to EMI. When you do, it doesn't hurt to indicate whether your letter, in whole or in part, is intended for publication or not.

Subscribers can place ads or other blurbs of up to 40 words in the Notices column free of charge. EMI's notices function as an unclassified advertising section.

Although we do tend to get more than we can print, we are always interested in article submissions. Remember that it's a good idea to check in, by phone or letter, before undertaking a substantial writing project with EMI in mind.

EMI can always use new subscribers. As the saying goes, "tell a friend." Or, send us addresses for potentially interested people; we'll send information and a sample issue.

EMI's back issues, from the very first on down, are full of material that is as valuable now as it was when it first appeared. Those back issues remain available. Earlier ones are in the form of spiral bound, photocopied sets; more recent ones can still be had as individual issues. In the back pages of this issue you will find a subject index for articles that have appeared over EMI's six-year life span to date. Ordering information is there as well. And don't forget the cassettes: EMI puts out a tape at the end of each volume year, containing music from instruments that have appeared in the written journal during the year. The newest of these, the Volume VI cassette, will appear within a few weeks of this issue; you can order it or any of its predecessors now.

Sincere thanks to all who have contributed and continue to contribute, in so many different ways, to **Experimental Musical Instruments**. We're on now to year number 7.

NOTICES

available for each volume; see information below.

CASSETTE TAPES FROM EMI: **Our new tape, From the Pages of Experimental Musical Instruments**, Volume VI, will be available later this month, and we are taking orders now. Its predecessors, Volumes I - V are also still available. Prices are $6 per volume for subscribers; $8.50 for non-subscribers (each volume is one cassette). Each tape contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Order from EMI, Box 784, Nicasio, CA 94946.

A REMINDER -- Unclassified ads here in EMI's notices column are free to subscribers for up to 40 words; 30 cents per word thereafter. For others they are 30 cents per word, 15 word minimum, with a 20% discount on orders of four or more insertions of the same ad.

MICROTONAL MIDI TERMINAL (vers. 1.2) by Denny Genovese lets you play nearly any MIDI synthesizer in Just Intonation! A veritable "tuning processor" as well, it has many features for constructing, editing, transposing, analyzing and printing Just Scales. Tuning data is shown in Ratios, Cents, Frequencies and Yamaha TU's. Those without a MIDI instrument can hear the Just scales on the computer's built in speaker. Holds 16 scales in memory, which are selected by single keystrokes. Tunings may be transposed into any key with another quick stroke. Requires IBM XT/AT or compatible and, for performance, an MPU-401 or compatible MIDI interface. $60 from DENNYS SOUND & LIGHT PO Box 12231 Sarasota, FL 34278.

WIND, STRING, PERCUSSION DEMO/TECHNIQUE CASSETTE -- 60 min.. Waterphones on side A, many other instruments & sound devices on side B. Send $8 + $2 (pack. & ship. -- $3 for overseas). $8 is deductible from purchase. Richard Waters, 1462 Darby Rd., Sebastopol, CA 95472, USA.

5TH ANNUAL SAW PLAYER'S PICNIC, JULY 21, 1991. Place: Harvey West Park in Santa Cruz, CA. Bring your musical instruments, saws, friends and picnic lunch to the fun get-together of saw players. The picnic will take place from 10 a.m. to 6 p.m. and will include open mike, workshops and jamming. A $5 donation will be collected at the picnic. Save the date!

SYMPOSIUM 91 of the Association of Stringed Instrument Artisans will take place in Easton, PA June 27 - 30. For information contact: Symposium 91, The Association of Stringed Instrument Artisans,14 Broad St., Nazareth, PA 18064. (215)759-7100

SUSAN RAWCLIFFE will be performing with her odd and exotic ceramic flutes and whistles: MAY 31-Logos Foundation, Gent Belgium; JUNE 1 or 2-Het Apollohius, Eindhoven, Netherlands; JUNE 8-Fete de la Congne, Nice, France; JUNE 11-Ademuge, Aixen Provence.

KEN BUTLER'S MUSICAL INSTRUMENTS are exhibited at The Metropolitan Museum of Art,82nd Street and Fifth Ave., NY,NY 10028 (212)879-5500, April 16 - June 23, 1991. Ken's imaginative, hybrid stringed instruments are assembled from household and found objects, including violins made of an axe and a bicycle seat, briefcase, bicycle wheel guitars and more complex assemblages incorporating miscellaneous parts of wood, plastic and metal.

DISNEY MAGIC MUSIC DAYS 1991 INTERNATIONAL MUSIC FESTIVALS. The 1991 International Harmonica Festival: August 3-4. Featuring educational workshop sessions, performance forums and appearances by top-name professional talent. Back by popular demand, the International Musical Saw Festival-September 21-22. For information: Disney Magic Music Days, International Music Festivals, P.O. Box 3232, Anaheim, CA 92803

CRAFTING MUSICAL GOURD INSTRUMENTS: 5-day workshop conducted by Larry Sherman at Miami University, Oxford, OH, during July 1991. Contact: Rhonda Via, Workshop Coordinator for CRAFTSUMMER, Rowan Hall, Miami University, Oxford, OH 45056 (513)529-7395.

EMI'S 6-YEAR INDEX

This is a subject index for articles that have appeared in **Experimental Musical Instruments** since it began publication in June of 1985. Articles are listed here by primary topics only; passing references are not indexed.

For an issue-by-issue listing of articles along with the contents of the EMI cassette tapes, see our back issues listing, sent once a year to subscribers or available on request. Back issues are available for $3.50 apiece for Volume VI #1 and subsequent. Earlier issues are available in photocopied, spiral bound volume sets (the Volume I set contains the 6 issues of EMI's first volume year; Volume II the six issues of the next year, and so forth up through Volume V), at $14 per volume. All from **Experimental Musical Instruments**, PO Box 784, Nicasio, CA, 94946.

NATURAL MATERIALS INSTRUMENTS: BONE, HORN, SEAWEED, ETC.
(see also Bamboo, Gourd)

ONE MAN BANDS

ORGANIZATIONS & PERIODICALS

ORGANOLOGICAL THEORY, SCHOLARSHIP & SPECULATION

PERCUSSION

PERCUSSION AEROPHONES

PLUCKED, TAPPED & HAMMERED STRINGS

PORTABLE INSTRUMENTS

RECORDINGS

REED INSTRUMENTS

SOFTWARE

SOUND RESONATORS AND RADIATORS
[Articles listed here devote special attention to noteworthy or unusual resonator systems in the instruments discussed.]

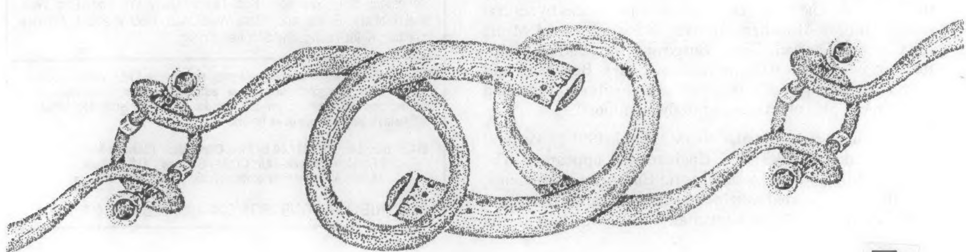
SOUND SCULPTURE, INSTALLATIONS & ARCHITECTURAL SOUNDWORKS
[See also reviews of exhibit catalogs listed under Books above, as well as listings under Exhibits, Festivals & Events.]

SYNAESTHESIA

TOOLS & TECHNIQUES

VOICE MODIFIERS

WHIRLED INSTRUMENTS



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Recent Articles in Other Periodicals

The following selected list contains articles relating to unusual musical instruments which have appeared recently in other publications.

"Collaboration: Tap Scored and Notes on the *Three Monk Tunes* for Tap Dancer" by Anita Feldman and Larry Polansky, in **Leonardo** Volume 23 #4 1990 (2030 Addison St., Berkeley CA 94704).

Anita Feldman describes her recent work in new forms for tap dancing. Included are a brief reference to & a photograph of the Tap Dance Instrument, a MIDI-ized floor sculpture designed by Feldman and Daniel Schmidt, on which a dancer can produce different pitches and timbres through tapping.

"Hugh Davies," an interview (in French) in **Notes: le Magazine des Autres Musiques** (16 rue Hignard, 44000 NANTES, France).

Hugh Davies, in addition to his scholarly work in 20th century organology, is also an instrument maker. His works often involve household items and small electronics.

"Michel Deneuve Blends Together Tones and Emotion as Crystallist from France" in **Glass Music World** Vol. 5 #2, April 1991 (2503 Logan Dr., Loveland, CO 80538).

Michel Deneuve is the leading performer on the Crystal, the extraordinary glass and steel rod instrument created by the Baschet Brothers. This short article describes Deneuve's work, and includes two photographs of the instrument.

"Imagining Whale Songs" by Tom Rebold in **The Interspecies Newsletter**, Spring 1991 (273 Hidden Meadow Lane, Friday Harbor, WA 98250).

Tom Rebold describes his efforts to come up with a means of transcribing whale songs into some usable and reasonably compact notational or computer data form.

"Under the Crown and Eagle" by Lloyd P. Farrar, in **Newsletter of the American Musical Instrument Society** Vol. XX #1, Feb. 1991 (c/o Shrine to Music Museum, 414 E. Clark St., Vermillion, SD 57069-2390).

This is an installment in Lloyd P. Farrar's continuing chronicle of some early American musical instrument manufacturing enterprises. This one includes a reproduction of an ad for the slide saxophone, "The Latest Sensation in the Musical Field."

"Sonic Disturbance 1990" by Charlotte Pressler, in **Ear** Vol. 15 #8 (131 Varick St., Room 905, New York NY 10013).

This is a review of the sound art festival called Sonic Disturbance that takes place annually (it's now two years old) in Cleveland. The reviewer discusses appearances by several artists: Gordan Monahan (*Speaker Swinging*), David Myers (aka Arcane Device), Diana Burgoyne (transmitting sculptures in interaction with the human body), Ben Neill and Nicolas Collins (mutant trumpet and trombone-controlled electronics), plus others more briefly mentioned.

The Galpin Society Journal XLIV, March 1991 (7 Percival Avenue, London NW3 4PY, England) has appeared. The society's primary focus is on historic European instruments, with this year's journal weighted toward articles on lutes and early keyboards. There is also an interesting letter in the correspondence section discussing lithophones made in England in the latter part of the 19th century. Another out-of-the-ordinary item is a paragraph in the Notes and Queries section concerning an old post card photograph showing a pair of bell harps (zithers designed to be swung about as they sounded for pretty directional effects).

The 1990 edition of the **Journal of the American Musical Instrument Society**, Volume XVI has appeared. Included are articles on a certain 16th century claviorganum (keyboard with both pipes & strings), an 18th century oboe maker, collecting instruments in the Soviet Union, and keyless oboes. The article on the oboe maker contains wonderful old woodcuts of early woodworking machinery.

Xenharmonikon 13, Spring 1991 (from Frog Peak Music, Box A36, Hanover, NY 03755) contains articles by ten different authors on various aspects of just and equal tempered tunings, including scores for a pieces in 7- and 13-tone ET, a couple of BASIC programs for intonational calculation and scale generation, plus several theoretical articles and reviews.

Musicworks 49, Winter 1991 (1087 Queen St. West, Toronto, Ontario M6J 1H3, Canada) has a special focus on new sound constructions. See the discussion under Notes from Recent Correspondence in this issue of EMI.